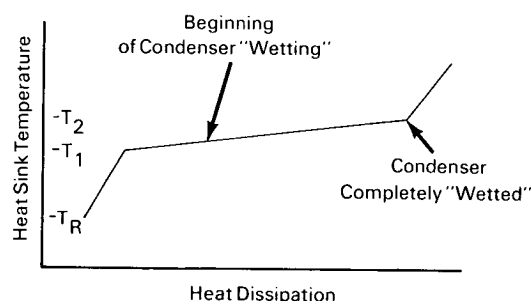
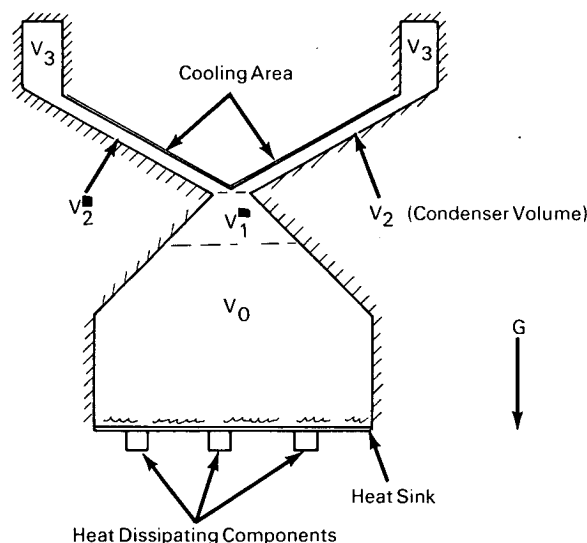


# NASA TECH BRIEF



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## High Conductance Vapor Thermal Switch



A high conductance vapor thermal switch has been produced to maintain heat dissipating component temperatures within acceptable limits. The switch is a self-actuating, automatic device that regulates the rate of heat flow to control, within a relatively narrow range, the temperature of elements whose heat dissipation or ambient heat sink temperatures vary over a wide range.

The device is a sealed pressure vessel (left figure) of particular geometry containing a vapor with an appropriate saturation temperature-pressure relationship, a reservoir of its condensed liquid, and a predetermined quantity of noncondensable gas. For purposes of this discussion, water and air are the two enclosed substances.

With the gravity field in the direction indicated, there is a small pool of water wetting the entire bot-

tom of the vessel termed "heat sink." Mounted to the exterior of this metal heat sink are the heat dissipating components, with high thermal conductance between components and water. The vessel is constructed of thin, relatively low thermal-conductivity material such as stainless steel, so that there is no appreciable heat transfer by conduction from the heat sink bottom to other areas of the vessel. Pressure within the vessel is well below atmospheric, so that at room temperature ( $T_R$ ) water vapor would occupy a volume  $V_0$  within the vessel and air a volume of  $(V_1 + V_2 + V_3)$ , if there were an actual separation of water vapor and air. Associated with the volume  $V_2$  is the cooling area (or condenser) of the system, the only vessel surface directly connected to the heat sink ambient. All other surfaces are thermally insulated from the ambient.

(continued overleaf)

Operation of the device is as follows. With no heat dissipation, the temperature throughout will be ambient; as heat is dissipated, the temperature of the heat sink and water pool will rise as indicated in the right figure with internal pressure correspondingly rising. When the temperature and pressure rise to the design condition of  $T_1$  and  $P_1$  (same as  $T_R$  in right figure), the volume of entrapped air, distinctly separated from the water vapor, will be compressed to a volume  $(V_2+V_3)$ ,  $((V_1+V_2+V_3)$  to room temperature), with water vapor occupying the volume  $(V_0+V_1)$ . Any higher temperature (and thus higher pressure) will compress the air further and water vapor will be in contact with the cooling area associated with volume  $V_2$ . Assuming the effective ambient temperature is lower than  $T_1$ , heat will be transferred from the water vapor to the cooling area, with the water condensing and returning by gravity to the pool above the heat sink. Thus, heat is absorbed by the water pool as heat of vaporization, then is carried by the vapor to the cooling area (condenser) where the heat is released in condensing. As this vapor mass flow and heat transfer occur, there will be a slight temperature and pres-

sure gradient from the pool to the condenser area, with a resultant distinct separation of water vapor and entrapped air.

**Notes:**

1. The thermal conductance of the water vapor path in the device is extremely high; the only significant thermal resistance is the path from components to water pool and from condensed water to the cooling ambient.
2. Documentation from the invention is available from:

Clearinghouse for Federal Scientific  
and Technical Information  
Springfield, Virginia 22151  
Price \$3.00  
Reference: B68-10519

**Patent status:**

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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